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Radiance Temperatures at 150 nm of Niobium and Molybdenum at Their Melting Points

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Abstract

Radiance temperatures at 1500 nm of niobium and molybdenum at their normal melting points were measured by a pulse-heating technique. The method is based on resistive self-heating of a strip-shaped specimen up to melting in less than one second by a high-current pulse. During heating, the radiance temperature is measured by means of a high-speed infrared pyrometer with a sampling time of 0.5 ms. When the specimen is melting, a nearly horizontal plateau in the radiance temperature versus time function develops. The radiance temperature for a given specimen is determined by averaging the measured values along the plateau. The standard deviation of individual values from the mean is 0.1 K to 0.3 K. Twelve to 13 experiments were performed for each element under investigation. The results for radiance temperatures at 1500 nm are as follows: 1983 K for niobium and 2050 K for molybdenum. The expanded uncertainties arising from pyrometry and specimen conditions are 8 K.

In alphabetical order:

Keywords: Emissivity; High temperatures; Melting; Molybdenum; Niobium

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Nomenclature (if appropriate)

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1 Introduction

Ambient pressure melting-point radiance temperatures of selected pure metals have been suggested as the basis of high-temperature references for secondary calibrations of optical pyrometers [1]. Such calibrations require an accurate knowledge of the wavelength dependence of the radiance temperatures of the metals. Over the past two decades, extended measurements in the wavelength range from 500 nm to 1000 nm have been made at the National Institute of Standards and Technology (NIST), Gaithersburg, MD, USA [2,3] and the Istituto di Metrologia “G. Colonetti,” Torino, Italy [4-6].

References are numbered consecutively with Arabic numerals in the order that they appear in the text. Reference numbers in text are enclosed in brackets.

2 Experimental Apparatus and Procedures

2.1 Specimens and Their Purities

2.2 Description of Experimental Technique

2.2.1 Principle of Technique

2.2.2 Apparatus

2.3 Experimental Procedures

2.3.1 Measurement of Temperature

2.3.2 Estimated Uncertainties

3 Results

The radiance temperature of niobium at the normal melting point of 13 melting plateaus and other pertinent results [2,3] are presented in Table 1.

4 Conclusion

Acknowledgments

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Examples:

References

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4. R. Masui, *Int. J. Thermophys.* **23**, 991 (2002)
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6. M.P. Allen, D.J. Tildesley, *Computer Simulation in Liquids* (Clarendon Press, Oxford, 1987)
7. M.P. Allen, D.J. Tildesley, in *Computer Simulation in Liquids* (Clarendon Press, Oxford, 1987), pp. 17-25

Each table (numbered with Arabic numerals) on a separate page (insert after references); units in parentheses; footnotes in tables designated by superscripted lower-case alphabetical characters:

Table 1 Summary of measurements of the radiance temperature at 1500 nm of Nb and Mo at their respective melting points

Experiment No.	Number of temperatures ^a	Radiance temperature at melting ^b (K)	<i>SD</i> ^c (K)
Nb			
1	100	1983.3	0.1
2	250	1983.3	0.3
3	250	1983.3	0.2
4	250	1983.3	0.2
Mo			
1	200	2524.7	0.2
2	200	2524.4	0.2
12	120	2524.4	0.2

^a Number of temperatures used in averaging the results at the plateau to yield an average for the radiance temperature at the melting point of the specimen

^b Average value (for an experiment) of measured radiance temperature at the plateau

^c Standard deviation of the measured temperatures from the average value of the plateau in an individual experiment

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Figure Captions

Fig. 1 Functional diagram of the high-speed measurement system

Fig. 2 Radiance temperature as a function of time at a wavelength of 1500 nm in the vicinity of the normal melting point

Fig. 3 Comparison (on ITS-90) of literature values and present results for the normal spectral emissivity of niobium and molybdenum at their melting points

Each figure on a separate sheet (insert after figure captions); axis labels – parameters and units separated with commas

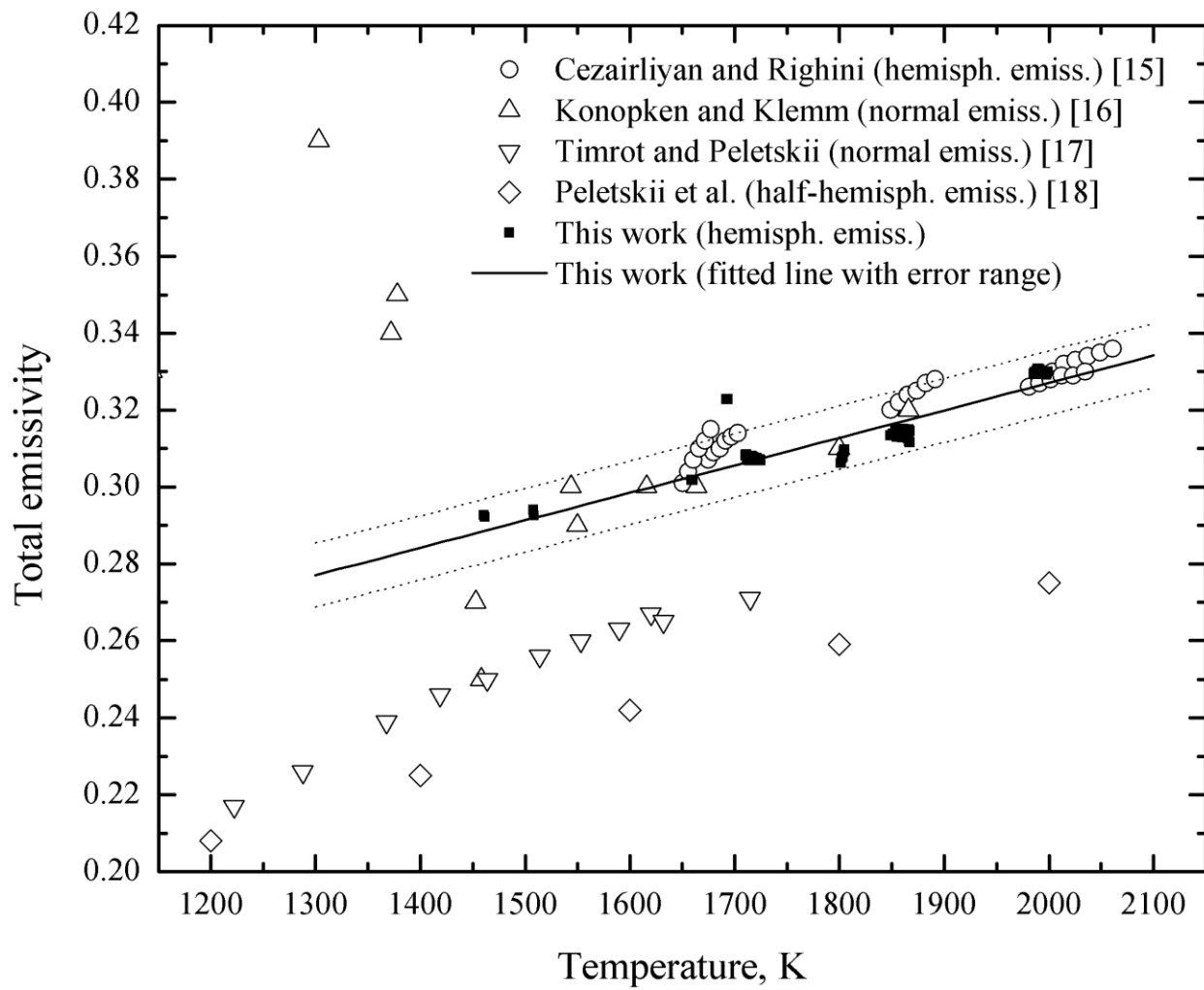


Fig. 1

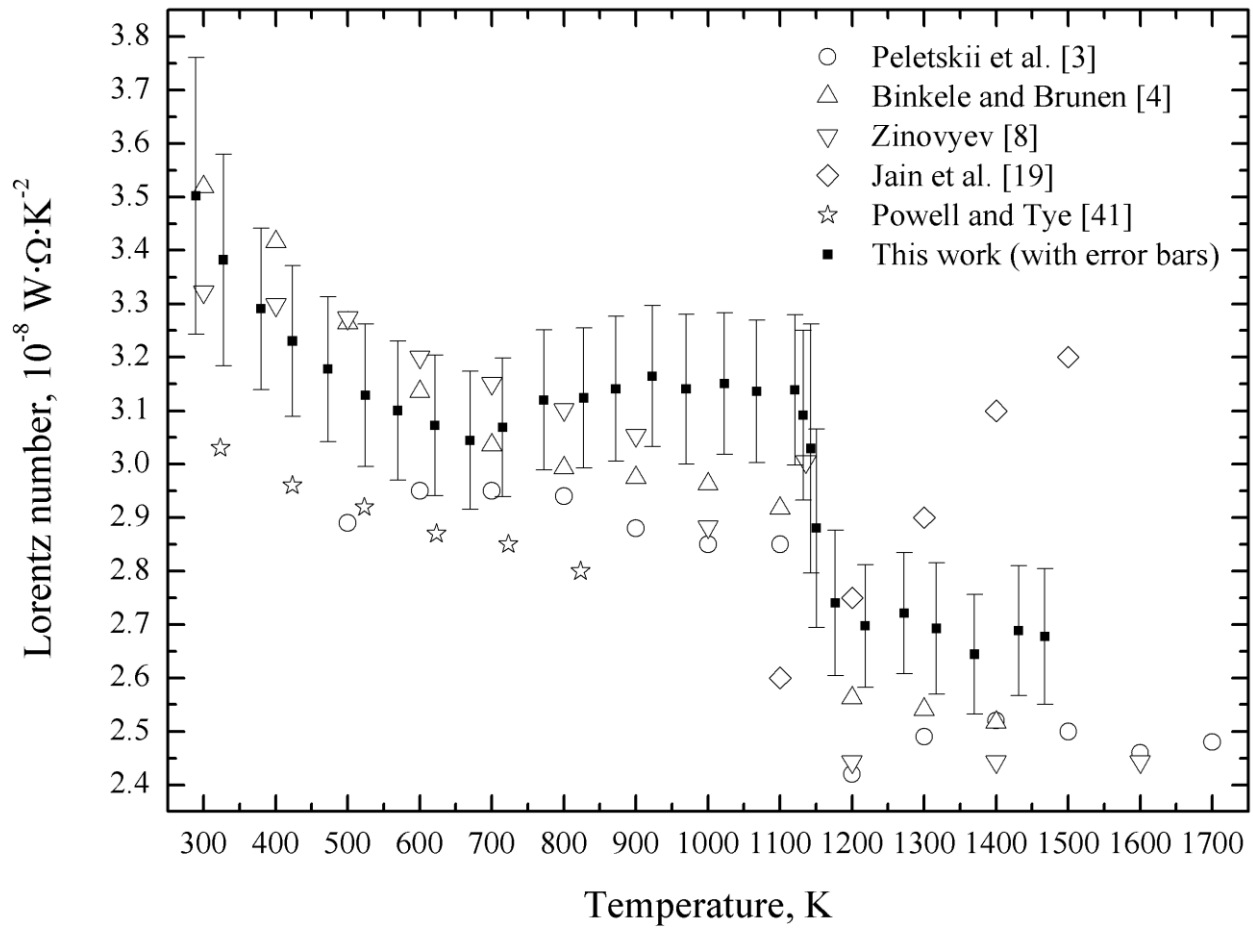


Fig. 2

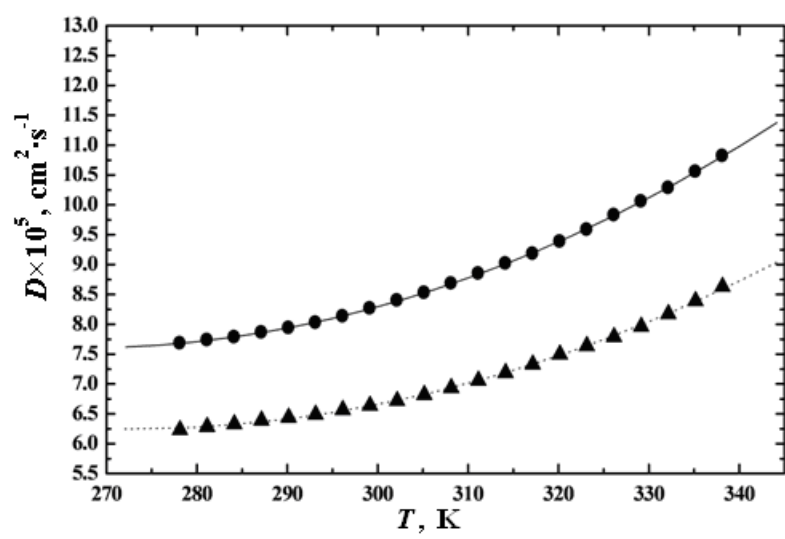


Fig. 3

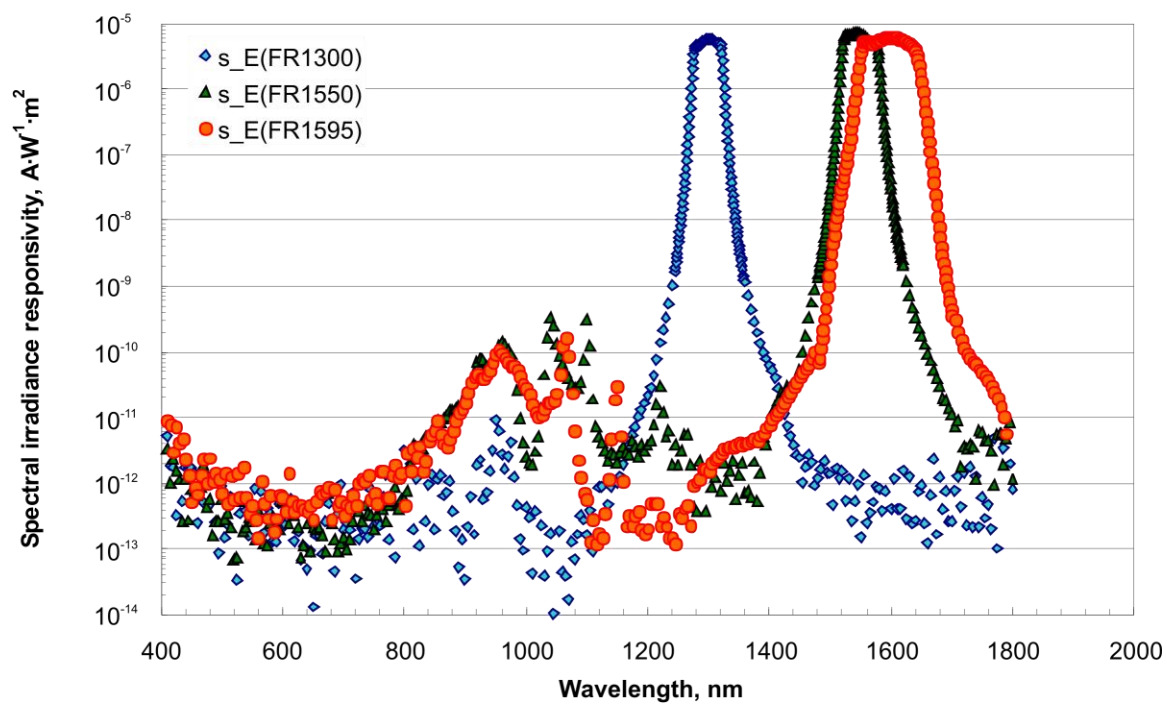


Fig. 4 (use scientific/standard exponential notation, not E notation)

Format for units (use “center dots” between components of units)

Examples:

Thermal conductivity: $\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$

Thermal diffusivity: $\text{m}^2\cdot\text{s}^{-1}$

Specific heat: $\text{J}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$

Density: $\text{kg}\cdot\text{m}^{-3}$

Equations are numbered consecutively with Arabic numerals in the order that they appear in the text, e.g.,

$$a + bT = 4.179 \quad (1)$$

$$PV = nRT \quad (2)$$

$$PV = Nk_{\text{B}}T \quad (3)$$

Refer to equations in the text as Eq. 1, or as Equation 1 at the beginning of a sentence

All symbols for variables and quantities should be in italics

All symbols for units should be in roman font

All symbols for descriptive terms (including subscripts) should be in roman font